

NOTES AND EXTRACTS.

FORMATION OF HAILSTONES.

A recent letter from Mr. William M. Taylor, at Guthrie, Okla., forwarded by Section Director C. M. Strong, describes a thunder and hailstorm as follows:

In the spring of 1868, at Arlington, Okla., I had the pleasure of observing a severe electrical and hailstorm. From 4 to 5 p. m. there was a continuous flashing of lightning, mostly forked, with very little thunder. About 6 p. m. it commenced to hail; the sky had a greenish cast and before the hail began to fall a rumbling noise was heard like stones clashing together. The first hail that fell was small, about the size of birds' eggs, but as the storm advanced they grew larger, until some of them crashed through the roof of the hotel and other buildings, including the roof of my shop, which was covered with three thicknesses of oak boards and had a slope of one in four. I examined several of these hailstones; one of them measured $3\frac{1}{2}$ by $4\frac{1}{2}$ inches in diameter. One was weighed by a friend and weighed 14 ounces. I broke several of them open to see their interior formation. The smallest had a center of white ice, with a coating of clear ice surrounding it. The next larger size was like the first, with an additional coat of white ice, and on that a coat of clear ice. Each successive larger size had additional double coats of white ice and clear ice. The largest had five double coats besides the center.

Although it has long been known that large hailstones are formed of concentric layers of clear ice and snowy ice, and although Espy and Ferrel long since plausibly explained this concentric formation on the assumption that the hailstones were carried alternately from the altitude called "rain stage" through the layer called "hail stage" into the upper layer known as the "snow stage" and back again, several times, we have not yet attained to what may be called a perfect demonstration of the truth of this very plausible hypothesis. In Ferrel's *Recent Advances* (Washington, 1885), and elsewhere, he has given some drawings illustrating his idea on the subject. His drawing on page 309 appears to suggest that hailstones of the larger size may be carried from the height of 2000 meters up to 8000 and back again over and over, until they have acquired a number of concentric coatings of ice and snow, but this is an extreme case and quite unnecessary. The beautiful graphic methods of Herz and von Bezold, and the more elaborate tables published by Professor Bigelow, or the new diagrams published by Neuhoﬀ, show that for any given condition of the atmosphere the so-called hail stage, in which raindrops are freezing into ice, occupies only a thin horizontal layer somewhere in the midst of an ordinary cumulus cloud, and this layer is at the most only a few hundred meters thick. Therefore, a hailstone need only go up and down vertically a few hundred meters, in order to receive a layer of snow or white ice, and down again a few hundred meters in order to acquire a layer of cold water. This vertical oscillation need not be represented by a curve like *AB*, followed by the direct fall to the ground *BC*, but rather resembles a curve, *XYZ*, such as would be described by a particle drawn in from a great distance outside of the storm at *X* and gradually ascending into the interior of the cumulus cloud at *Y* before it is brought to the ground at *Z* by its increasing weight. The altitude at which the hail stage occurs depends upon the temperature and humidity of the air, and is somewhat higher in the interior of the cloud than at its exterior, as represented by the stratum *HH* in fig. 1.

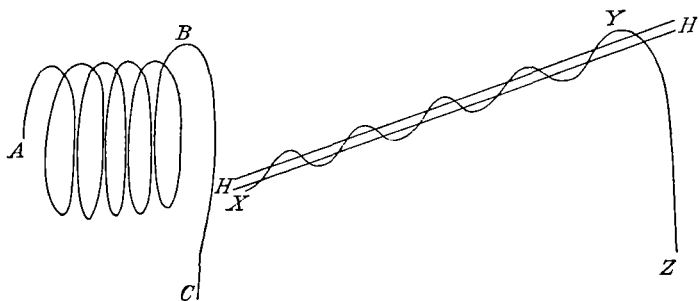


FIG. 1.—Formation of hailstones.

WEATHER BUREAU MEN AS INSTRUCTORS.

Prof. Henry J. Cox, in charge at Chicago, states that classes in physiography in the schools of Chicago and vicinity frequently visit the office of the Weather Bureau. Fourteen such visits occurred during 1903. One of these classes was from the University of Chicago, another, a class in physics, from the Young Men's Christian Association Technical School, and the remainder were from the high schools and normal schools of Chicago. On each occasion a lecture was delivered, either by Professor Cox or by one of his assistants, upon the working of the Weather Bureau instruments, the methods employed in forecasting, etc.

On December 16, 1903, Mr. D. A. Seeley, Observer, lectured before the Oakland Culture Club at one of its regular monthly meetings on "Meteorology and Weather Forecasting."

Mr. Weston M. Fulton, Local Forecaster, reports the delivery of a lecture at Chattanooga, Tenn., on December 18. Between 2000 and 2500 persons were present, and considerable interest was manifested in the subject.

Mr. J. R. Weeks, Observer, Weather Bureau, Macon, Ga., delivered the first of a series of lectures December 23 before the students of the Gresham High School on "The Weather and the Weather Bureau."

METEOROLOGY AND THE ART OF FLYING.

During the past four years a series of most interesting experiments have been going on on the coast of Dare County, N. C., not far from the Weather Bureau station at Kittyhawk. Here the brothers, Wilbur and Orville Wright, of Dayton, Ohio, have established a camp and all the necessary apparatus for experiments in what is known as gliding flight. The apparatus, which is a form of aeroplane, is launched from the summit of a sand hill, and after making a long glide finally comes to rest on the sands below. After several years of experience and careful study of the currents and winds that blow over the sand hills, the Messrs. Wright have applied motor machinery to their aeroplanes. Their success is undoubtedly due in great part to the preliminary careful study of the winds, and for this reason, although machinery is essential, yet we consider that meteorology also has played an important part in their work. Their latest official announcement is that on December 17 four flights were made. The wind record at Kittyhawk was 24 to 27 miles per hour at 30 feet above the ground, but at the flying station it was about 22 miles per hour at 4 feet above ground. These flights were made from the level ground, against the wind, with no assistance from gravity: after a horizontal run of 40 feet the aeroplane rose with the operator on a very gentle incline to a height of 8 or 10 feet from the ground, after which the course was kept as nearly horizontal as the wind gusts and the limited skill of the operator would permit, and the flyer made its way forward with a speed of 10 miles per hour over the ground, or 30 to 35 miles per hour relative to the air. The fourth flight occupied 59 seconds and the machine flew through a distance of 852 feet over the ground, or about three times that distance relative to the wind; it landed earlier than was necessary, owing to a slight error of judgment on the part of operator.

The Messrs. Wright state:

It had not been our intention to make any detailed public statement concerning the private trials of our power "Flyer" on the 17th of December last; but since the contents of a private telegram, announcing to our folks at home the success of our trials, was dishonestly communicated to newspaper men at the Norfolk office, and led to the imposition upon

the public by persons who never saw the "Flyer" or its flights, of a fictitious story incorrect in almost every detail; and since this story, together with several pretended interviews or statements, which were fakes pure and simple, has been very widely disseminated, we felt impelled to make some corrections. The real facts were as above.

THE THERMOPHONE APPLIED TO GEODESY.

We have several times had occasion to call attention to the convenient and accurate thermophone of Messrs. Henry E. Warren and George C. Whipple, who applied it first to the measurement of the temperature of water in lakes and afterwards to the temperature of the soil. We now also call attention to its application in determining the temperature of a base measuring tape, as used in geodesy. We quote the following from a recent report by John F. Hayford, published as Appendix No. 3 in the Annual Report of the United States Coast and Geodetic Survey for 1901:

Little has yet been published in regard to this apparatus (See Technology, Quarterly, June, 1901, p. 82). It has been developed gradually during the last fourteen years by students of the Massachusetts Institute of Technology, acting under the direction of Prof. A. E. Burton, several theses having been written on different phases of the subject.

The important feature of this form of tape apparatus is the device for obtaining the temperature of the tape. The whole length of the 100-meter tape and an approximately equal length of German-silver wire form two of the arms of a Wheatstone bridge. The two variable arms of the bridge, together with the telephone which is substituted in the place usually occupied by a galvanometer, and the necessary interrupter, batteries, and connections form the thermophone proper. The thermophone has been patented by Messrs. Henry E. Warren and George C. Whipple, and is manufactured by E. S. Ritchie & Sons.¹

It has been used for determinations of temperature in various ways, and the work of the students at the Massachusetts Institute of Technology now under consideration is mainly that of developing this apparatus to use with long measuring tapes.

The electrical resistance of the steel tape varies more rapidly with a change of temperature than does that of the German silver. The ratio of the resistance of the tape to that of the German silver is, therefore, a measure of their temperatures. Or, with sufficient accuracy, it is a measure of the temperature of the tape, provided the German silver is similarly exposed, so as to have approximately the same temperature as the tape. This ratio is the quantity really measured by the thermophone. The thermophone dial, over which moves a pointer which indicates the position of the contact point regulating the two variable arms of the bridge, is graduated so as to indicate the temperature of the tape in Fahrenheit degrees.

In regard to the Massachusetts Institute tape apparatus as a whole, the writer is convinced: That with the thermophone apparatus in its present form, and using all refinements, measures can be made even in daylight, and when the temperatures are varying rapidly, with a much higher degree of accuracy than is possible with tapes and mercurial thermometers even under good conditions at night.

PERIODS IN SOLAR RADIATION AND TERRESTRIAL TEMPERATURES.

An important communication from Mr. C. G. Abbot of the Astrophysical Observatory, "Recent Studies of the Solar Constant of Radiation," is reprinted in this number of the MONTHLY WEATHER REVIEW.

It is true that the Editor's article in the American Journal of Science, 1870, vol. 750, p. 345, did seem to show that the temperatures observed at Hohenpeissenberg, when treated by a purely statistical method, support the idea that the sun sends us less heat at the time of the sun-spot maximum and that the diminution amounts to about 0.8° R. for 100 units in Wolf's relative sun-spot numbers. For a long time after that publication the Editor believed that it might be possible to establish an intimate connection between solar radiation and solar spots, but the steady development of our knowledge of the selective absorption of the earth's atmosphere has shown that we can not argue by crude statistical methods from terrestrial temperatures up to solar radiation. We may speak of periods and variations in our temperatures, but these do not

demonstrate similar periods in the sun's temperature or in its radiations, since unsuspected periodic variations in the earth's atmosphere may be the cause of the variations that we should otherwise attribute to the sun itself.

When we consider the temperature of the earth's atmosphere in and of itself, without asking where the heat comes from, we do find slight traces of irregularities that seem sometimes like regular periods. But these irregularities and periods do not necessarily originate in the sun, even though some of them do show that our low temperatures come at the time of sun-spot maxima. It is quite as likely that they originate in the earth's atmosphere by the combined action of moisture, winds, or currents. It is demonstrably impossible for any period whatever to permanently exist in the earth's atmosphere. We may have forced periods, such as the diurnal and the annual, but there are no natural periods like those of a tuning fork. If a sun-spot period is manifest anywhere, it is either forced and maintained by the sun spots, or else it is a temporary phenomenon that soon dies away. The mere fact that there is a decrease of temperature in the Tropics at sun-spot maximum argues nothing as to a direct relation of cause and effect between the two phenomena. We have on hand a collection of monthly charts of temperature departures for the whole globe for several successive years, which tend to show that the apparent sun-spot periods in the earth's temperature are purely local, terrestrial matters, moving around from one part of the world to the other, just as do our droughts and our rains, our barometric waves, and our cold waves. We have an analogy in the movement of an oceanic earthquake wave over the globe, going sometimes rapidly and sometimes slowly, reflected from a continent, exaggerated in some arm of the ocean, breaking in waves on a shore, but scarcely felt on an island in mid-ocean, and finally dying out by virtue of innumerable interruptions, as all forced waves do unless they happen to be reinforced by a process similar to that of resonance in sound waves.

If in thus speaking of sun-spot periods and lunar periods as matters of minor importance to meteorology we have seemed to dissuade anyone from spending his time in study along those lines, we have done this with a view, not to discouraging research, but to urging that attention be given to more important fields of research. If one is so constituted that he can study nothing but solar and lunar periods, then let him do that, and possibly some benefit to meteorology may result; but to one who has any general ability in research we must urge that he take up what may be called the internal mechanism of our atmosphere, or the movements and phenomena that must occur in a complex atmosphere resting on the variegated surface of the earth under the influence of a constant emanation from the sun. He will find within the atmosphere a series of periodicities due to the diurnal rotation and the annual revolution of the earth; another series due to the dimensions of the globe and the mass of the atmosphere, and still another series due to the variations of land and water, vapor, cloud, and rain or snow. We would have our best men unravel this internal mechanism before studying the less important and rather problematic celestial influences.

SOUTHPORT EXHIBITION OF METEOROLOGICAL APPARATUS.

At the Southport meeting of the British Association, August, 1903, there was, as usual, an exhibition of scientific apparatus which, on the present occasion, referred especially to meteorology and terrestrial magnetism. The catalogue of the exhibition covers 30 pages, and includes, among other things, the following items that will interest the meteorologist on account of their rarity or novelty:

1. Maps of the world, showing the isobars for June 21, September 21, and December 21, 1901, and March 21, 1903.

¹Mr. Warren writes that it is now manufactured by the Lombard Governor Co., of Boston, of which he is superintendent.—Ed.